SCIENCE

VOL. 81 FRIDAY, MAY 17, 1935 No. 2107

The Mechanism of Enzyme Actions: DR. K. GEORGE FALK 471

Obituary:

Michael Idvorsky Pupin: PROFESSOR A. P. WILLS 475

Scientific Events:

Annual Meeting of the Trustees of Science Service; Annual Meeting of the American Academy of Arts and Sciences; Retirement of the Secretary of the Zoological Society of London; Award of the Daniel Guggenheim Medal for Aeronautic Achievement to William Frederick Durand; Recent Deaths 479

Scientific Notes and News 481

Discussion:

Foreign Geographic Names: DR. EUGENE VAN CLEEF. *Further Attempts to Grow Chilomonas paramecium in Inorganic Media:* J. B. LOEFER and PROFESSOR R. P. HALL. *Shall Smoky Cities Go Treeless?:* PROFESSOR H. B. MELLER and L. B. SISSON. *The William Herbert Centennial:* DR. HAMILTON P. TRAUB. *The Ganesh Prasad Prize:* PROFESSOR DAVID EUGENE SMITH 484

The American Association for the Advancement of Science:

Minutes of the Executive Committee Meeting: DR. HENRY B. WARD 487

State Academies:

The Pennsylvania Academy of Science: DR. BRADFORD WILLARD. *The Alabama Academy of Science:* PROFESSOR P. H. YANCEY. *The Tennessee Academy of Science:* PROFESSOR J. T. MCGILL. *The Minnesota Academy of Science:* PROFESSOR H. K. WILSON 489

Scientific Apparatus and Laboratory Methods:

On an Arrangement for Studying the Conditions within Diffusion Layers: DR. TORSTEN TEORELL. *A Simple Reliable Time Clock:* DR. G. B. RAY and H. LEWINE 491

Special Articles:

Mutation Rate from Old Datura Seeds: DR. J. L. CARTLEDGE and DR. A. F. BLAKESLEE. *The Relation of Water and Electrolytes to Metabolism:* DR. HARRY A. DAVIS. *Calcifying Factors in the Diet of Salamander Larvae:* DR. ESTHER M. PATCH 492

Science News 6

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THE MECHANISM OF ENZYME ACTIONS[1]

By Dr. K. GEORGE FALK

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IN making up the program of the symposium on enzymes for this meeting, the speaker was asked to discuss the mechanism of enzyme actions. The ground to be covered was not further specified. In thinking over the possible topics to be considered, it was soon evident that everything related to an enzyme action might be included, but this would make the treatment a hopeless one. Perhaps it would be as well not to attempt an exhaustive review, but rather to present some personal conclusions and relations based upon the experimental and theoretical work and study over a considerable period of time, as time is reckoned by the individual.

Ten years ago, in a monograph on enzyme action, the speaker wrote a chapter on the mechanisms of such actions. The conclusions presented there in rather elementary fashion have been supplemented since, but unfortunately, the relations have not been simplified. Rather the complexities of the problems have become more generally recognized, and while the simpler relations may still be said to hold, they furnish only the beginnings of the real study of the problem of the mechanisms of such actions.

It would be rather easy to present a number of facts of enzyme actions and to draw conclusions limited to the cases in point from them. To such an audience as this the facts of enzyme actions are known. To repeat them is unnecessary and also boring. To present some more general relations and views may perhaps be useful, more for the purpose of raising questions than of answering them.

[1] Presented at the Symposium on the Chemistry of the Enzymes held by the Divisions of Agricultural and Food Chemistry and of Biological Chemistry of the American Chemical Society, Cleveland, Ohio, September 11, 1934.

In the first place, what is meant by mechanism of enzyme actions? Enzyme actions are chemical actions; enzymes are materials causing chemical changes in various substances. This raises the question of the mechanism of chemical actions and reactions in general. In a monograph published six years ago by the American Chemical Society, F. O. Rice[2] discussed the "Mechanism of Homogeneous Organic Reactions." He brought out clearly the difficulties involved in such studies and stated[3]: "It is not a matter for discouragement that the mechanism of organic reactions is, in great part, so uncertain. . . . It does not seem likely, however, that there will be any remarkable advance by proceeding along classical lines, and we may look for this only through the development of some new method. . . ." In view of the more complex nature of enzyme reactions involving substances in the colloidal state, etc., in comparison with the homogeneous organic reactions which were treated by Rice, the outlook for understanding the mechanism of enzyme actions is not hopeful, to say the least.

Enzyme actions have been and are included in the group of catalytic actions. This does not add anything to the understanding, either of enzyme actions or of catalytic actions, so nothing more will be said of this relationship, or comparison, or classification, or whatever it may be called.

Having put forward the worst imaginable view, it will now be possible to go ahead with the statements of some of the relationships which have been proposed.

To any one working with enzyme actions, the rates of chemical reactions or the amounts of changes in definite times, brought about or influenced by these enzymes, is the predominatingly important factor. The accurate experimental determination and interpretation of such rates obviously is an essential feature of enzyme studies. In an attempted evaluation of the results of such studies a most disconcerting fact appears. There is no standardized method of studying these actions. Apparently, most of those who have made extended studies of the velocities of enzyme actions have developed what may be called individualistic methods of carrying out the experiments or of presenting these results in mathematical form.

The experimental methods of measuring enzyme changes may first be considered. For a few enzyme actions the methods appear to be simple and have been generally adopted. For most, however, individualism runs wild. For example, for such a comparatively simple action as fat or ester hydrolysis, in the methods used, one chemist, apparently to fix conditions, adds a mixture of sodium oleate, calcium chloride and albumin to the enzyme material; another adds nothing at all but allows the acid formed progressively in the reaction to do what damage it may; one uses a stalagmometric method successfully, another is unable to obtain results with it; buffers of different compositions are added, although it is recognized that each such buffer may modify the action in its own way; and so on. This list could be elaborated endlessly and with other enzymes. All this may be said to have culminated in the protease work of Northrup, who uses twelve different methods of protease testing to determine similarities and differences in his crystalline protease preparations.

Then, on the theoretical side, the most obvious way of handling an experimental series of results mathematically is to apply the reaction velocity equations to them. The simple monomolecular reaction rate, involving the substrate, early was found to hold either not at all or only for limited ranges of change for many enzyme actions. Then came modifications of this equation, factors added to account for the products of reaction combining with the enzyme and so removing it from the sphere of action, of the reaction taking place in steps, etc., all accounting or reproducing mathematically the changes within more or less limited ranges. Terms to include adsorption were introduced. Empirical terms were proposed. The most extreme treatment was that of Nelson and Hitchcock[4] who developed an empirical equation, containing four constants, to reproduce the results on the hydrolysis of cane sugar by invertase. Many of the equations suggested, both theoretical and quasi-theoretical, are well known to those here to-day.

The following statement was made some years ago:[5] "The three concepts—chemical reaction, chemical equation and mathematical equation—are supposed to describe the same phenomenon in any given case. Actually they do so only as an ideal condition, and the possibility of deviation becomes greater with increasing complexity of the reactions and with decreasing care in the use of terms and expressions." Evidently, enzyme actions involving unknown enzyme materials and mixtures, on the one hand, and changes in complex materials, such as proteins, etc., on the other hand, are not readily amenable to simple theoretical treatment.

What does all this mean? Is there any way out of this apparent muddle, if it is a muddle? First, it will be necessary to philosophize a little. The measurements and studies were made by chemists of various kinds and degrees. Now, it is possible to divide chemists into three groups. There are, first, the self-starters; second, those who must be cranked occasionally; and third, those who must be towed their whole

[2] American Chemical Society, Monograph Series, Monograph No. 39, Chemical Catalog Co., Inc., New York.

[3] Page 19.

[4] *Journal American Chemical Society*, 43: 26–32, 1921.

[5] "The Chemistry of Enzyme Actions," 1924, p. 36.

lives. For the purposes in view, only the first two classes need be considered, the self-starters and the cranked. The third group, the so-called towees, add much at times to the vociferousness of the proceedings and help to fill the journals; but for a true study of the value of their concepts such mass action for once must be given small consideration. Caution must be used in determining what methods are of real value.

To what does all this lead? Different methods are used by different workers. Each worker interprets his results from a different view-point. In the main, this means that this branch of science is new and in the making. The methods are not standardized, and it may be said that each contributor adds something to help build up the structure of enzyme actions. For example, Levene[6] finds that hydrolysis of certain dipeptides by hydrogen ion and by erepsin are based upon the same type of actions, Bergmann is following this up and extending these relations, while Waldschmidt-Leitz has been separating a number of peptidases and is developing a branch of the subject whose implications are not by any means clear. The hydrolysis of cane sugar by invertase, perhaps the most carefully and most accurately studied of all enzyme actions, leaves much to be asked for, if a real knowledge of the mechanism of its action is desired.

In general, the study of the kinetics of enzyme actions has not thrown any conclusive light on the mechanism of such changes. Perhaps the only conclusion which seems justified at present and which is widely accepted is that addition compounds of enzyme and substrate are formed which then break down to form the products of enzyme actions. Such addition compounds have not been isolated as chemical individuals. The evidence for their presence is indirect and to that extent perhaps doubtful, but to assume their presence is useful and possibly true.

Can anything further be said of the mechanism of enzyme actions? As is well known, because of the nature of the materials, the experimental study is extremely difficult. However, it is desired to present some views, which are perhaps personal, but which represent, at least to one chemist, some of the directions which enzyme studies are taking.

In the first place, a real and great advance has been made in the obtaining of enzyme materials as crystalline proteins of constant properties, first by Sumner for urease, and then by Northrop for pepsin and trypsin and by Sherman for amylase. This part of the subject of enzymes does not properly come under the topic of the mechanism of such actions. Indirectly it will play a most important part, as it will be possible to work with more definite materials. It also has a bearing upon another phase of the enzyme problem to be discussed presently. The fact that these enzyme preparations are protein in character, and in fact have been considered to be pure proteins, is a matter which can not be overlooked. At various times the question was raised, whether protein material was a necessary constituent of the active enzyme. Careful experimental studies are required to throw light on these questions. For example, for the enzyme pepsin, the view was advanced recently that the active enzyme was not necessarily protein but could be transferred from one protein substance to another. This view was shown to be erroneous, and as far as evidence is at present available, these crystalline proteins act as the enzymes. What the chemical composition of other enzymes may prove to be can not be foretold. It would seem that lipases and esterases are also protein in composition, and that at the other extreme is invertase, which has been found always to contain nitrogen, although possibly to only a small percentage, even in its most highly purified state. It is of interest that the two enzymes, lipase and invertase, at opposite extremes as far as chemical composition is concerned, have just been brought together with regard to certain relations involving the mechanisms of their actions. This relationship will be considered presently.

The second point of advance to which it is desired to draw attention has to do with the influence of added substances on enzyme actions. Added substances can modify many chemical reactions and especially the velocities of the reactions. It is therefore not surprising that added substances should modify enzyme actions most profoundly in many instances. If this were all that were involved—a listing of enzyme actions whose velocities were changed—there would be little or no justification for presenting these relations here. It is desired, however, to present a point of view which is based upon some of these relations; a point of view which some believe may aid in throwing light on the meaning and hence the mechanism of enzyme actions.

In an extended investigation[7] of lipase or esterase actions of extracts of a number of tissues and tumors of different animals, the ester-hydrolyzing actions on a number of different simple esters were determined under standardized conditions. Any one tissue gave definite, reproducible amounts of relative hydrolyses on these esters under the definite conditions. That is to say, if the tissue hydrolyzed twice as much of one ester as of another in one case, it did so in every experiment. Different tissues gave different amounts of the relative hydrolyses, so that it was possible in a number of cases to identify the tissue by means of the relative ester-hydrolyzing actions of its extract. Added proteins did not modify these relative actions, nor did

[6] P. A. Levene and H. S. Simms, *Jour. Biol. Chem.*, 62: 711, 1925.

[7] K. G. Falk and associates in various publications.

mixing two tissue extracts modify the actions which were found to be additive in these cases. If, however, a highly active preparation, such as pancreas extract, was tested alone, and then after the addition of different proteins, it was found that one protein would increase the hydrolytic action on one ester and another protein the hydrolytic action on another ester. There was a selective or directive influence on the action of the enzyme due to these added proteins. Such relations were clearly pointed out in 1925 by Platt and Dawson[8] and extended recently.[9] It seems that with impure enzyme preparations the proteins and perhaps other substances present interfere with the influence of added protein. With purer enzyme, added protein exerts a specific directive effect. Similar results are being reported by Nelson and Saul with invertase, in a paper which is appearing this week in the September issue of the *Journal of the American Chemical Society*. Here, only amounts of actions are involved, but the experimental methods permit of a high order of accuracy. The hydrolytic action on cane sugar of highly purified invertase at pH 3.0 is increased by added protein. The action of crude invertase is not influenced by such added protein.

It is possible to speculate endlessly about the meaning and significance of these results. Undoubtedly, they are of the highest importance for the proper understanding of the mechanism of enzyme actions, especially since it is probable that other enzyme actions will be found to show similar relations. Only a few points will be mentioned and these only sketchily. Certain phenomena of enzyme behavior have been explained by assuming the active enzyme to be a definite chemical grouping or part of a molecule, stabilized by the remainder of the generally colloidal molecule. This view has been widely publicized in recent years. Some remarks may perhaps be permitted in this connection. In the first place, Sumner[10] pointed out the indefiniteness of this point of view, which is flexible enough to meet any number of experimental results. Secondly, this point of view is not of recent origin. It seems to be the most obvious way of looking at the facts of enzyme actions chemically. It was put forward by Perrin[11] in 1905, by Matthews and Glenn[12] in 1911, by Röhmann and Shmanine[13] in 1912, by the speaker[14] in 1918, by Willstätter[15] in 1922, and possibly by a number of others whose publications have been overlooked.

It is a convenient way of thinking about the phenomena, but in itself is quite incomplete. This raises the next question: What might be the true nature of the combination between enzyme material and proteins which may be added or which are already present? Apparently the classical valence theory is inadequate. To call the compounds "adsorption compounds" covers a volume of ignorance. It is to be hoped that a view of chemical combination, possibly an outgrowth of the older valence theories, possibly a development of energy relationships and including the quantum theory in some form, will develop which will permit a rational formulation and description of these combinations.

The mechanism of enzyme actions, as a rule, is taken to apply to simplified enzyme actions in the laboratory. There is, however, a more profound view which may be taken. That is, the mechanism of enzyme actions in the living organism may be considered. Following the discussion of the influence of proteins on such different enzymes as lipase and invertase, it is evident that enzymes in every living organism must be influenced by the apparently inactive materials present. Sometimes these influences or substances may exert directive actions, as with proteins on lipase; sometimes they may increase the actions as shown with proteins on invertase under the special conditions or with proteins on the hydrolyzing action of papain on glyceryl triacetate,[16] sometimes the actions may be decreased, and finally, the possible action of one enzyme on another in the living organism must be considered.

The enzyme in the living organism never acts alone or in a pure state; the external factors play a possibly predominating rôle. Perhaps the enzyme may be called the hereditary factor, and what actually occurs in any given case depends upon the other substances present or the environment. This is an interesting thought to play with but must not as yet be taken too seriously. The mechanism of enzyme actions in the living organism offers a vast field for study. A beginning has been made. Time permits only a reference. In the breakdown of glucose by yeast, the various steps in the process whereby different products are obtained under different conditions are gradually being elucidated. The scheme of Neuberg[17] and quite recently that of Meyerhof and Kiessling[18] are undoubtedly familiar. Here, a number of enzyme actions are involved and the possible complications are many, as

[8] *Biochem. Jour.*, 19: 869, 1925.
[9] K. G. Falk, *Jour. Biol. Chem.*, 96: 53, 1932.
[10] SCIENCE, 78: 335, 1933.
[11] J. Perrin, *Jour. Chim. Physique*, 3: 50, 1905.
[12] A. P. Mathews and T. H. Glenn, *Jour. Biol. Chem.*, 9: 29, 1911.
[13] F. Röhmann and T. Shmanine, *Biochem. Zeit.*, 42: 235, 1912.
[14] K. G. Falk, SCIENCE, 47: 423, 1918.
[15] R. Willstätter, *Ber. Chem. Ges.*, 55B, 3601, 1922.
[16] K. G. Falk, *Jour. Biol. Chem.*, 103: 363, 1933.
[17] *Cf.* the review by W. Fuchs, *Sammlung chemischer und chemisch-technischer Vorträge*, 27: 1, 1922.
[18] O. Meyerhof and W. Kiessling, *Biochem. Z.*, 267, 313-48, 1934.

you all know. Such studies, the results of which can be carried over to glucose breakdown in bacterial metabolism with necessary modification for any given case, and then perhaps brought into relation to muscle metabolism, would be a real triumph for a more useful understanding of the mechanism of such actions.

It would be possible to go on indefinitely in this strain. However, just one more thought will be presented. One of the points which it is desired to emphasize here is the action of added substances on enzyme actions. In other words, in these phenomena of living matter and of life processes it is the system as a whole which must be considered. This thought is not new, but it is frequently overlooked or ignored, possibly because of the aim to make the study of chemical phenomena objective as far as possible. In another field of chemistry, the simple ionic theory which treated of ions as independent entities has come to be modified to include the properties and actions of the solvent, of the ions on each other, of the influence of non-ionized substances on the properties of the solvent and of the ions, etc. It would be possible to give many other chemical illustrations, especially from the field of organic reactions. In every case, for a proper understanding of the reaction, all the factors and their interrelationships must be included. It is therefore obvious that in the complex mixtures of living matter the reciprocal influences of the constituents must be considered. For life processes, therefore, the understanding of the functioning of any one of the parts, and consequently also of the functioning of the whole, must necessarily treat of the system as a whole. This point of view is in contradistinction to the present trend of physics, to work down toward the ultimate particles of energy or matter. These two aims are not in contradiction, both are needed for a complete understanding of the phenomena involved. But further, in considering the system as a whole and the influences of various substances on enzyme actions and the surprising results obtained at times, it might appear as if these studies are being developed from the view of "Emergent Evolution." Although the latter might perhaps be considered as a philosophy of ignorance, yet it sets definite problems and raises questions which may or may not be answerable.

If the mechanism of enzyme actions were better understood, it would be an approach from the chemical side to the science of life itself. The biologist is working toward simpler units of cell constituents. Apparently, the genes are the simplest such units so far achieved. Their molecular weights are perhaps in the neighborhood of 50,000. Davenport[19] considers that they probably are enzymes and presents views relative to their development and actions, analogous to some of the views presented here. This is a tempting subject, and much of interest may be expected in this field in the near future.

Finally, in considering the mechanism of enzyme actions as outlined here, several specific questions may be asked. What is meant by "protein molecule" and by "pure protein"? What new concepts of forces or means of combination must be developed to account for the reactions observed? How do proteins, and perhaps other substances, act in modifying certain enzyme actions? And finally what sort of a mechanism in the living organism permits of the continuity of the enzyme formations and actions which are needed for the continuance of the given life process?

OBITUARY

MICHAEL IDVORSKY PUPIN

IN the small village of Idvor, not far from Belgrade, in the Austrian province of Banat, now a part of Yugoslavia, Michael Idvorsky Pupin was born on the fourth day of October, 1858.

His parents, Constantine and Olympiada, were Serbian peasants who could neither read nor write; they were prosperous and highly esteemed members of the community. From them he inherited a remarkably strong physique, an exceptional mental endowment and an oriental imagination.

His formal education was begun in the village school of Idvor, where he learned reading, writing and arithmetic, and was continued in the schools of Panchevo and Prague.

Eventually, while a student in Prague, he became so incensed at the Teutonic oppression of the Slavs in Bohemia that he decided to emigrate to America, where, he had come to believe from what he had learned in the schools at Panchevo and Prague, real freedom was to be found, and where, he thought, a young immigrant might make his way to fortune.

Late in March of the year 1874 he landed, practically penniless, as an immigrant in New York City. Shortly after landing, in an encounter with a crowd of newsboys, whose gibes at his headgear, a red fez, had aroused his resentment to fighting pitch, he demonstrated his ability to take care of himself. An onlooker, a Delaware farmer, impressed by his performance, offered him a job on his farm, which he declined, since his duties would have included the milking of cows, which in accordance with Serbian tradition was a job for women. Another offer of a job, on a Delaware farm, bearing a satisfactory stamp

[19] C. B. Davenport, *Scientific Monthly*, August, 1934, pp. 104–108.

of masculinity, was presently made him and was accepted.

His job was to assist in the cultivation of the land by driving a pair of mules. Presently, a young woman of the farmer's family interested herself in his welfare, and under her tutelage he rapidly acquired a considerable knowledge of the English language and some acquaintance with American history and customs.

After a few weeks he set forth on a search for new experiences, and in the course of a few days he obtained another farm job, driving a pair of mules, in southern Maryland. After a month he left it and returned to New York City, where, he thought, his chances for advancement would be better than on a farm.

It was summer in the year 1874, and the country was still in the midst of the depression which started with the financial panic of 1873. Thousands of unemployed men patrolled the streets in search of jobs, and for many days Michael Pupin was one of these. In the course of time he found work doing odd jobs, such as transferring coal from sidewalks to cellar bins, and painting cellar walls. Through the winter of 1874–5 in one way or another he managed to pay his room rent and provide himself with fairly regular meals, though sometimes a meal was nothing more than "a bowl of soup and a chunk of brown bread."

Eventually, he found steady employment in the New England Cracker Factory in Cortlandt Street. Here, among the employees of the factory he made two friends who exerted no little influence on his career. These were Jim, the boiler engineer, a man with little education but nevertheless a philosopher and a wise counsellor, and Bilharz, a man with a fine education, particularly in the classics, but broken in spirit through some misfortune, and reduced to his present lowly employment. These friends encouraged him to prepare himself for college. This he did by studying Greek and Latin grammar in his spare time under the guidance of Bilharz, attendance at the night classes held in Cooper Union and later by full-time attendance at the Adelphi Academy in Brooklyn. In the fall of the year 1879 he passed with high standing his entrance examinations for Columbia College.

In college he won scholastic distinction in Greek, mathematics and physics. He devoted comparatively little time to athletics, but through his prowess in wrestling and boxing he won the approbation of his classmates, who elected him president of the class for the junior year. In his senior year his interest in physics was greatly stimulated through the lectures of Professor Ogden Rood, and he decided upon a scientific career.

On the day preceding his graduation from Columbia in 1883 Michael Pupin received his naturalization papers and became an American citizen.

Although he had been offered fellowships which would have enabled him to continue at Columbia for three years, he finally decided to go abroad for graduate study in physics.

In June of the year 1883 he embarked for Europe, nine years after his arrival in America as an immigrant. After a preliminary visit to Cambridge he returned to Idvor for his first visit home since his departure for Prague in the year 1872. He found his mother "much older, and much more beautiful" and, of course, eager to hear from his own lips the story of his life and achievements in America. His father had died during his stay in Prague.

He returned to Cambridge in October and began his studies in mathematical physics under the preceptorship of the celebrated coach John Edward Routh, fellow of Peterhouse College. Rayleigh and Stokes were lecturing on mathematical physics, but Pupin was not yet prepared for the advanced courses which they were giving. Under Routh he acquired a mastery of dynamical methods which was an invaluable asset in his later scientific activities.

After two years in Cambridge he decided to go to Berlin for laboratory work under the direction of the celebrated von Helmholtz. Fortunately, at this time Pupin was offered by President Barnard of Columbia a John Tyndall fellowship. He accepted without delay, and thus became the first John Tyndall fellow.

In October, 1885, he arrived in Berlin with letters of introduction from President Barnard and Tyndall, and was kindly received by Helmholtz. During his first year in Berlin he attended the course on experimental physics given by Helmholtz, and also lectures on the theory of electricity and magnetism given by Kirchhoff, who had not yet, however, given his adherence to the views of Faraday and Maxwell, with which Pupin himself was now in full accord.

At this time he had become interested in the new science of physical chemistry, and was cognizant of the work of J. Willard Gibbs, which he brought to the attention of Helmholtz. He received his Ph.D. degree from the University of Berlin in 1889, submitting a theoretical dissertation dealing with the subjects of osmotic pressures and free energy.

In the fall of the year 1889 he began his long teaching career at Columbia University with the title of "assistant teacher of mathematical physics in electrical engineering." In 1892 he was made adjunct professor of mechanics, and in 1901 was advanced to a full professorship, with the title of professor of electro-mechanics. When in 1905 the departments of mechanics and physics were united, he became a member of the department of physics, with which he re-

mained in active service until 1929, when he was made professor of electro-mechanics in residence.

His own predilections were for research rather than teaching. The dominant and magnetic personality with which he was endowed was a great asset in his teaching, which was characterized by a remarkable skill in bringing out the physical significance of mathematical formulae.

In 1889, when he joined the newly created department of electrical engineering at Columbia, Pupin and his friend, Francis B. Crocker, constituted the teaching personnel of the department. The basic theoretical courses were given by Pupin in morning lectures, and he was also required to assist in the laboratory instruction in the afternoons. Notwithstanding this heavy teaching load, he found time in the evenings to carry on with experimental research.

His earliest work was concerned with the phenomena associated with the discharge of electricity through gases, and his experimental investigations in this field led to results which had an important bearing on the electromagnetic theory of the solar corona.

He next occupied himself with the experimental investigation of the peculiarities exhibited by wave forms of alternating currents to which Rowland of Johns Hopkins had called attention. His familiarity with the methods of Helmholtz in detecting the harmonics in vowel sounds enabled him to develop corresponding methods for the analysis of alternating current wave forms. This he accomplished through the use in electrical circuits of adjustable induction coils and condensers. He was thus led to the discovery of the methods of tuning which are essential in the art of radio broadcasting and communication. The results of this important investigation were published in the Transactions of the American Institute of Electrical Engineers for 1894.

In December, 1895, Roentgen announced his epoch-making discovery of x-rays. Two weeks later, on January 2, 1896, Pupin obtained the first x-ray photograph made in America. With the aid of a fluorescent screen, furnished by his good friend, Thomas A. Edison, superimposed upon a photographic plate, he was enabled to obtain an excellent x-ray picture with an exposure of but a few seconds.

In a communication to the New York Academy of Sciences on April 6, 1896, he announced the discovery of secondary x-ray radiation, and is now generally accorded priority for this discovery.

On April 15, 1896, Professor Pupin was stricken with pneumonia, and for several days was critically ill. The necessary months for convalescence from this dread disease he spent in the beautiful town of Norfolk, Connecticut, in the Berkshire Hills, to which he became greatly attached. Several years later he acquired possession of a farm near the town, and using stones from the fields, he built his picturesque summer home, to which he was accustomed to go whenever possible, not only for rest, but also for the opportunity to work free from the distractions of city life.

Upon recovery from his illness he returned to the consideration of a problem which had occurred to him on a summer vacation journey through Switzerland in 1894. While in Cambridge ten years previously he had read Lagrange's paper, "Recherches sur la Nature et la Propagation du Son," in which the solution was given of the problem of a vibrating string fixed at both ends and loaded at equal intervals with equal masses. He now proposed to attack a new problem, obtained by generalizing the conditions imposed by Lagrange, through assuming the string itself to have weight and the medium surrounding the string to exert a dissipative reaction to its motion. Not realizing at the time the tremendous practical importance of the problem, if it could be solved, he nevertheless attacked it with great vigor and eventually found its solution.

The solution of this problem furnished the solution of a precisely analogous problem relating to the propagation of electromagnetic signals over a telephone line periodically loaded with inductance, and with distributed capacity. Professor Pupin's solution of this analogous problem consisted essentially in showing that the malevolent influence of the capacity and resistance of the line in causing distortion and attenuation of signals could be nullified through the introduction of inductance coils at specified intervals along the line. It led to an invention which was of the first order of importance in the telephone art. For it enables telephone engineers to design their lines so as to avoid undue distortion and attenuation of signals. In fact, it makes possible long distance telephony by overhead lines or by undersea cables, and the replacement of overhead lines when desirable by underground cables, as, for example, in cities and large towns. In Germany telephone lines equipped with the Pupin inductance coils are called "pupinizierte linien," in France "les lignes pupinizé."

In order to obtain an experimental confirmation of the mathematical theory of his invention which would convince practical engineers of its utility he was forced to construct an "artificial" telephone line in his own laboratory. The mathematical theory of his artificial line was communicated to the American Institute of Electrical Engineers in March, 1899.

The American patent rights to Professor Pupin's telephone inventions were acquired by the American Telephone and Telegraph Company on terms not fully commensurate with the value of the invention

but highly satisfactory to him, and which enabled him later to foster many philanthropic enterprises in which he was deeply interested.

Not long afterwards he disposed of the patent rights relating to his wireless inventions to the Marconi Company of America.

For a number of years following the first announcement of his telephone invention he was absorbed in the mathematical consideration of problems connected with the theory of telephonic communication, and in laboratory research connected with the improvement of the toroidal inductance coils which are used on loaded telephone lines. He was thus diverted from active participation in the epoch-making developments which were meanwhile being made in physics during the first decade of the present century.

In 1909 he began to take an active interest in Serbian activities in the United States and became president of the society established in the interests of Serbian immigrants, serving in this capacity until 1926.

At the outbreak of the Balkan War in 1912 he was made honorary consul of Serbia in New York. He started at this time at his own expense a Serbian daily newspaper, mainly for the purpose of keeping Serbian immigrants informed as to the war movements in the Balkans. He also organized a Serbian sisterhood whose members were encouraged to collect contributions in aid of the Serbian Red Cross; and, in the interests of the Serbian National Defense League, to inspire volunteers for war service. In 1914 this work was extended throughout the United States, and highly satisfactory results were achieved.

When the United States entered the war in 1917, Professor Pupin organized a Columbia University group of scientists for the purpose of developing methods for the detection of submarines. He himself, notwithstanding his active duties as a member of the Committee of Aeronautics of the National Research Council, devoted much time and effort in the laboratory to the development of highly sensitive receiving devices for high frequency sound waves in water.

In 1919 he organized in New York City a Slavonic Immigrant Bank through which were reported daily in Slavic newspapers throughout the United States the rates of exchange for the currencies of the Balkan states, thus protecting immigrants from the predatory activities of unscrupulous money-changers. In 1920 he founded the Serbo-American Bank in Belgrade.

At the request of Premier Pashitch, Professor Pupin served as a representative of Serbia at the Paris Peace Conference in April, 1919. Here, in collaboration with his colleague Professor Douglas Johnson, of Columbia University, he was able to advance cogent arguments which resulted in extending materially the proposed boundaries of the newly created Kingdom of the Serbs, Croats and Slovenes—now known as Yugoslavia.

In 1922, at the age of sixty-four, he decided to write the story of his eventful life. In 1923 his autobiography, "From Immigrant to Inventor," was published. Here he unfolds the narrative of his life in a manner which holds the interest of the reader from beginning to end, and in a literary style which is remarkable for its naiveté and poetic imagery. The appeal of this book to the general public far exceeded the expectations of the author. It has been translated intc several foreign languages, and letters of appreciation from all over the world gave the author the comforting assurance that the time and labor which he had bestowed upon its preparation were not in vain. On account of a persistent demand an abridged edition of this book was prepared, suitable for use in the public schools.

In 1927 his second popular book was published under the title, "The New Reformation," with the sub-title, "From Physical to Spiritual Realities." The book consists of a series of seven popular disquisitions on science, or narratives, as the author designates them, written with a purpose in view which can be inferred from the concluding words of the author's prologue—"It is hoped that by strengthening our understanding of the physical realities the narratives will reform our mental attitude and make it better prepared for the recognition of the truth that physical and spiritual realities are the fruit of the same tree of knowledge, which was nurtured by the soil of human experience." In this book he has revealed the simple and rational philosophy of life to which he adhered and the spiritual sentiments which were a part of his religious faith.

But brief mention can be made of the many philanthropic enterprises which he fostered. Among these was a foundation for the Royal Serbian Academy in Belgrade in memory of his mother; one for the education in agriculture of young Serbs of Voyvodina; one for the restoration of old Serbian monasteries; and one for the establishment of a community house in his native town of Idvor.

In recognition of his scientific and literary achievements Professor Pupin was honored by the bestowal upon him of numerous honorary degrees by universities in America and Europe; he was also the recipient of many honorary medals; and in 1925 he was elected president of the American Institute of Electrical Engineers and also president of the American Association for the Advancement of Science.

In the latter years of his life Professor Pupin was

afflicted with a paralysis which deprived him almost entirely of the use of his legs. This infirmity he bore with cheerful fortitude, and despite it continued his intellectual activities until stricken with the illness which resulted in his death on the twelfth day of March, 1935.

In his memory and honor the trustees of Columbia University at their first meeting subsequent to the death of Professor Pupin voted to name the recently-erected physics building the "Pupin Physics Laboratories."

A. P. WILLS

COLUMBIA UNIVERSITY

SCIENTIFIC EVENTS

ANNUAL MEETING OF THE TRUSTEES OF SCIENCE SERVICE

AT the annual meeting of Science Service, held in Washington on April 25, three new trustees were elected as follows: Dr. Harlow Shapley, director of the Harvard College Observatory, representing the National Academy of Sciences; Dr. Henry B. Ward, permanent secretary of the American Association for the Advancement of Science, representing that organization; Dr. Ludvig Hektoen, director of the John McCormick Institute for Infectious Diseases, representing the National Research Council.

Trustees reelected were: Dr. R. A. Millikan, of the California Institute of Technology, representing the National Academy of Sciences; R. P. Scripps, of the Scripps-Howard Newspapers, representing the E. W. Scripps Estate, and Marlen Pew, editor of *Editor and Publisher,* representing the journalistic profession.

Dr. J. McKeen Cattell, editor of SCIENCE, was reelected *president.* Other officers reelected were: Dr. W. H. Howell, of the Johns Hopkins University, *vice-president* and *chairman of the executive committee;* H. L. Smithton, of the Scripps-Howard Newspapers, *treasurer,* and Watson Davis, director of Science Service, *secretary.* Dr. C. G. Abbot, secretary of the Smithsonian Institution, and Mr. Pew were reelected members of the executive committee.

Dr. Vernon Kellogg, secretary emeritus of the National Research Council, who retired as a trustee, was elected honorary vice-president in appreciation of his long service in the office of vice-president. Dr. William E. Ritter, of the University of California, is honorary president.

The following resolution was adopted upon the death of Dr. David White, of the U. S. Geological Survey, who at the time of his death was a trustee of the service:

RESOLVED, That the Board of Trustees of Science Service desire to express their sincere feeling of sorrow and personal loss in the death of Dr. David White. His long and valuable services as a trustee, as a member of the Executive Committee and as chairman of the Executive Committee are recognized and deeply appreciated by his fellow members as constituting an important factor in the successful initiation and development of the work of Science Service. It is ordered this resolution be entered upon the minutes of the meeting of April 25, 1935, and that a copy be sent to Mrs. White.

Annual reports of Science Service for its fourteenth full year of operation, ended on March 31, 1935, showed that news and interpretations of scientific progress are furnished to over 6,000,000 readers through newspapers utilizing news and feature reports, issued by telegraph and mail daily, weekly and monthly. The weekly magazine, *Science News Letter,* gained in distribution, now having over 16,000 circulation.

Various books and magazine articles written and edited by members of the staff were produced during the year, notably the book entitled "The Advance of Science." Two radio talks each week were arranged over nationwide networks of stations.

Progress was made toward an extension of the work of the service in the British Empire and arrangements for the exchange of news with the Tass Agency of the U.S.S.R. were made.

Research aid activities consisting of the collection of earthquake information, the distribution of cosmic data, and the investigation of archeological and anthropological discoveries were continued.

The cost of operation during the year was slightly over $110,000. The endowment provided by the late E. W. Scripps yields $30,000 a year and the balance was more than covered by earnings.

ANNUAL MEETING OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES

AT the annual meeting of the American Academy of Arts and Sciences held in Boston on May 8, Dr. Roscoe Pound, dean of the Harvard Law School, was elected president. He succeeds Dr. George H. Parker, professor of zoology at Harvard University. The following were reelected vice-presidents: James Flack Norris, Walter Bradford Cannon, Edwin Francis Gay and Arthur Stanley Pease. Joshua Whatmough succeeds Robert P. Bigelow as editor. Councillors elected for four years are: Dugald C. Jackson, Ralph H. Wetmore, Arthur N. Holcombe and Kenneth J. Conant.

The following new members were elected in the scientific classes:

CLASS I—MATHEMATICAL AND PHYSICAL SCIENCES

Section 1, Mathematics and Astronomy. Gilbert Ames Bliss, Chicago.

Section 2, Physics. Charles Elwood Mendenhall, Madison, Wis.; Floyd Karker Richtmyer, Ithaca, N. Y.; Robert Jemison Van de Graaff, Cambridge, Mass.; Bertram Eugene Warren, Cambridge, Mass.

Section 3, Chemistry. Louis Harris, Cambridge, Mass.; Nicholas Athensius Milas, Cambridge, Mass.

CLASS II—NATURAL AND PHYSIOLOGICAL SCIENCES

Section 1, Geology, Mineralogy and Physics of the Globe. Oliver Lanard Fassig, San Juan, Porto Rico; Warren Judson Mead, Cambridge, Mass.; Derwent Stainthorpe Whittlesey, Cambridge, Mass.

Section 2, Botany. Bernard Ogilvie Dodge, New York, N. Y.; Sir William Wright Smith, Edinburgh (*Foreign Honorary Member*).

Section 3, Zoology and Physiology. Charles Henry Blake, Cambridge, Mass.; John Franklin Daniel, Berkeley, Calif.; Karl Friedrich Meyer, Berkeley, Calif.

Section 4, Medicine and Surgery. Tracy Jackson Putnam, Boston, Mass.

RETIREMENT OF THE SECRETARY OF THE ZOOLOGICAL SOCIETY OF LONDON

SIR PETER CHALMERS MITCHELL retired on April 29 from his post as secretary of the Zoological Society of London, after holding that office for thirty-two years.

At the society's annual meeting in the afternoon warm tributes were paid by the Duke of Bedford, president of the society, and other speakers to the great services which Sir Peter has rendered to the society, to zoology and to countless visitors to the Zoo in Regent's Park and its Whipsnade branch. As a memorial of these services a portrait of the retiring secretary, painted by William Nicholson, was presented to the society as a joint gift from more than 1,250 members. In the background of the painting is a map of the Whipsnade estate. The presentation was made by Sir Henry Mahon and Professor John Stanley Gardiner.

President G. Elliot Smith, of University College, London, writes to the London *Times* in part as follows:

> To-day Sir Peter Chalmers Mitchell retires from his post as Secretary of the Zoological Society of London, and that society loses the ablest and most accomplished of all those who have been the chief architects of its destiny. In his thirty-two years of service at the Zoo he introduced an order of excellence and efficiency to be found nowhere else in this or any other country. He transformed what had become little more than an "old menagerie"—and not a very prosperous one—into a place of really enthralling experience. He made himself, if anonymously, the friend of every child, and at the Zoo youth and age could meet and, hand in hand, enjoy themselves. Almost single-handed he fought the battle for light and air and freedom for the animals entrusted to his care. . . . He recognized, too, how important so great a collection of living creatures could become as a means of studying comparative pathology. His resources were placed at the disposal of workers in this field, and indeed in all other allied fields of research, so that he gathered round him a company of workers which included the most eminent among biologists, biochemists, dieticians and students of physiotherapy and tropical medicine.

In his address at the annual meeting the Duke of Bedford called attention to the fact that in 1902 there were six pairs of entrance turnstiles and about 69,500 visitors; in 1934 there were 17 pairs of turnstiles and 1,690,000 visitors. Before the recent wave of depression, for four years in succession they had each year more than 2,000,000 visitors.

The new secretary of the society is Professor Julian S. Huxley, a grandson of Thomas H. Huxley.

AWARD OF THE DANIEL GUGGENHEIM MEDAL FOR AERONAUTIC ACHIEVEMENT TO WILLIAM FREDERICK DURAND

DR. WILLIAM FREDERICK DURAND was awarded on May 3 the Daniel Guggenheim Medal for 1935, "for notable achievement as pioneer in laboratory research and theory of aeronautics; distinguished contributions to the theory and development of aircraft propellers."

This is the seventh award of the medal. It was made by a board having eight members in the United States of America and seven foreign members. All fifteen members are men of high standing in engineering and scientific activities of aeronautics. The foreign representatives are for Canada, England, France, Germany, Holland, Italy and Japan.

Professor Durand, because of his extensive travels and periods of residence in Europe, is well known internationally for his experimental research on aeronautic propellers and other features of aircraft. His publications have been numerous, and he is now producing a six-volume work on "Aerodynamic Theory," which is being published by Julius Springer, of Berlin. This encyclopedia contains contributions from numerous European and American authorities.

Dr. Durand was one of the first to engage in scientific research in aeronautics on his own initiative. He constructed at Stanford University a wind tunnel and conducted a long series of investigations on propellers. He has served on many committees and commissions. His services to the National Advisory Committee for Aeronautics and to the Daniel Guggenheim Fund for the Promotion of Aeronautics were most valuable.

During the war he was technical attaché to the American Embassy in Paris. In March, 1935, he was appointed chairman of a committee to advise the Navy Department on design and construction of airships with respect to general stability.

He is a life member and gold medalist of the American Society of Naval Engineers. He is a fellow of the Royal Aeronautic Society, a past-president of The American Society of Mechanical Engineers and a member of the National Academy of Sciences, the American Physical Society, the Society of Naval Architects and Marine Engineers and Société Technique Maritime.

Dr. Durand was graduated from the United States Naval Academy in 1880, obtained the degree of doctor of philosophy from Lafayette College in 1888 and received an honorary doctorate of laws from the University of California in 1927. He is now professor emeritus of mechanical engineering at Stanford University.

The Daniel Guggenheim Medal was established in 1928 and placed under the sponsorship of The American Society of Mechanical Engineers and the Society of Automotive Engineers jointly, each of which appoints four members of the Board of Award. The president of the 1934–35 board, which awarded the medal to Dr. Durand, was Major E. E. Aldrin, of The Standard Oil Company of New Jersey, and Arthur E. Nutt, of the Wright Aeronautical Corporation, was vice-president.

Previous recipients of the medal were Orville Wright, of the United States; Ludwig Prandtl, of Germany; Frederick William Lanchester, of England; Juan de la Cierva, of Spain; Jerome Clarke Hunsaker and William E. Boeing, of the United States.

ALFRED D. FLINN,
Secretary

RECENT DEATHS

DR. EDWIN BRANT FROST, director emeritus of Yerkes Observatory and professor emeritus of astrophysics at the University of Chicago, died on May 14 in his sixty-ninth year.

DR. MARSHALL HOWARD SAVILLE, professor of American archeology at Columbia University, died on May 7 at the age of sixty-seven years.

DR. LUCIAN W. CHANEY, formerly professor of biology at Carleton College and from 1908 until his retirement in 1930 statistical expert of the U. S. Department of Labor, died on May 6 at the age of eighty-seven years.

CHARLES THOMAS LUPTON, consulting geologist at Denver, Colo., died suddenly on May 8, at the age of fifty-seven years.

DR. WILHELM KOLLE, privy councillor and director of the State Institute for Experimental Therapy and of the Chemico Therapy Research Institute, at Frankfort, died on May 10 at the age of sixty-six years. Dr. Kolle succeeded Paul Ehrlich at the Franklin Institute in 1915.

SCIENTIFIC NOTES AND NEWS

DR. FRANK B. MALLORY, until his retirement in 1932 professor of pathology at the Harvard Medical School, editor of *The American Journal of Pathology,* was awarded the George M. Kober Medal by the Association of American Physicians at the recent Atlantic City meeting. The presentation was made by Dr. James Ewing, of the Cornell University Medical College.

THE Mendel Medal, awarded annually by Villanova College for research by a scientific man who is a Roman Catholic, was presented on May 7 to Dr. Francis Owen Rice, professor of chemistry at the Johns Hopkins University. The Very Rev. Edward V. Stanford, president of the college, made the presentation at a faculty dinner with an attendance of about two hundred.

THE laboratory award of $5,000 offered by Mead, Johnson and Company has been divided, one half being given to Dr. S. B. Wolbach, of Harvard University, for his "basic work on the pathology of avitaminosis A and his investigations on the regeneration of epithelial tissue impaired by vitamin A deficiency, and the relationship of vitamin A to the integrity of the teeth"; and one half to Dr. Karl E. Mason, of Vanderbilt University, for "distinguishing exactly between the pathology of avitaminosis A and avitaminosis E, and for his contribution to the quantitative relationship of vitamin A deficiency to the keratinization of germinal epithelia." The award of $15,000 to be given "to the investigator or group of investigators producing the most conclusive research on the vitamin A requirements of human beings" has been postponed until December 31, 1936.

Nature reports that the August Forel Foundation of the German Academy of Sciences at Halle, which is to award a prize every two years for researches in the subjects in which Forel was specially interested (eugenics, the alcohol problem, study of ants and the central nervous system), has made its first award to Dr. Graf, who is head of the department of industrial physiology at the Kaiser Wilhelm Institute of Dortmund.

ST. JOHN'S COLLEGE, Annapolis, will confer the honorary degree of doctor of letters on Dr. Raymond Pearl, professor of biology in the School of Hygiene and Public Health of the Johns Hopkins University, at its commencement exercises on June 5.

DR. EUGENE WILLIS GUDGER, of the American Museum of Natural History, has been elected to life membership in the North Carolina Academy of Science, "in recognition of his many years of active service with a spirit of loyalty to the academy and the state."

THE order of the Crown of Italy was formally presented on May 7 to President James Rowland Angell, of Yale University, by Augusto Rosso, the Italian ambassador. The order was conferred upon Dr. Angell with the rank of grand officer, the highest degree, for his part in improving cultural relations between Yale and the Italian universities.

DR. E. B. RENAUD, professor of anthropology at the University of Denver and French consular agent for Colorado, Wyoming and Utah, has been awarded the Cross of Knight of the French Legion of Honor for his scientific work in anthropology and archeology.

DR. R. T. WOODYATT, professor of medicine in Rush Medical College of the University of Chicago, was elected president of the Association of American Physicians at the recent meeting in Atlantic City. He succeeds Dr. Henry A. Christian, Hersey professor of the theory and practice of physic at the Harvard Medical School.

DR. JOHN LOVETT MORSE, professor of pediatrics, emeritus, at the Harvard Medical School, was given a dinner at the Country Club in Brookline on April 22 in honor of his seventieth birthday, which occurred on April 21.

DR. EDWARD WESTON, chairman of the board of the Weston Electric Instrument Company, celebrated his eighty-fifth birthday on May 9.

THE University Court of St. Andrews has recorded a minute on the occasion of the jubilee of the appointment of Professor D'Arcy W. Thompson to the university. As reported in *Nature*, "Tribute is paid to his outstanding worth and ability, not only in his own department of natural history but also in other departments of literary and scientific knowledge. His election to the presidency of the Classical Association testified to his knowledge of and interest in the ancient languages and literatures of Greece and Rome; his election as an honorary member and as president of the Edinburgh Mathematical Society in recognition of his pioneer work in the application of mathematical methods to biological studies was a guarantee of mathematical ability of no mean order; and his work as adviser to the Fishery Board for Scotland, and as a delegate to the Bering Sea Fisheries Conference and to the North Sea Conference indicated his international reputation as a scientific administrator."

SIX members of the faculties of the University of Minnesota will reach the retirement age this year. Among these are Dean William R. Appleby, head of the School of Mines and Metallurgy since it was established; Professor Andrew Boss, vice-director of the Agricultural Experiment Station at University Farm, and Professor Peter Christianson, metallurgy.

AT Harvard University Dr. Frederick F. Russell, general director of the International Health Board of the Rockefeller Foundation since 1923, has been appointed lecturer on preventive medicine and hygiene and epidemiology at the Medical School; Dr. Lars V. Ahlfors, now adjunct professor of mathematics at the University of Helsingfors, has been appointed lecturer on mathematics and tutor in the division of mathematics.

AT the University of Belfast, Dr. Henry Barcroft, lecturer in physiology at University College, London, has been appointed Dunville professor of physiology, and Dr. D. C. Harrison, lecturer in the University of Sheffield, has been appointed to the J. C. White professorship of biochemistry.

DR. HOWARD ADDISON ROBINSON, now a teaching fellow in physics at the Massachusetts Institute of Technology, has been appointed to the Irving Langmuir Fellowship of the American-Scandinavian Foundation. He expects to continue his work on spectroscopy in Sweden.

THE Electrochemical Society has awarded the seventh Weston Fellowship of $1,000, founded by Dr. Edward Weston, to Myron A. Coler, of New York. He will carry out his work on electrophoresis at Columbia University.

THE annual meeting of the Board of National Research Fellowships in the Biological Sciences, for the award of 1935–36 appointments, was held in Washington, D. C., on March 30 and 31, 1935. No reappointments were made at this meeting. Twenty-three new appointments were awarded as follows: For domestic study: *zoology,* Henry Alver Bess, Donald Randolph Charles, Frederick Crescitelli, Frances Sue Dorris, Graham Phillips DuShane, Allan Charles Scott and Benjamin Robert Speicher; *anthropology,* Cora Du Bois and Chas. Frederick Voegelin; *psychology,* Glen Finch, Ward Campbell Halstead and Edward H. Kemp; *botany,* Walter S. Flory, Jr., Winslow R. Hatch and Donald Philip Rogers; *agriculture,* Wm. B. Graham, Jr., and Harland G. Wood. For foreign study: *forestry,* Wm. Clark Bramble and Jas. W. Johnston, Jr.; *anthropology,* Helen L. Dawson;

agriculture, Lyman Arnold Dean; *zoology,* Richard Marshall Eakin; *botany,* Harold Norman Moldenke.

THE Committee on Scientific Research of the American Medical Association has made a further grant of $500 to Dr. L. A. Emge, clinical professor at the Stanford University School of Medicine, for his investigation of the effect of castration on benign and malignant tumor growth. This is the fourth grant that the committee has made for this study of transplantable tumors. Dr. G. E. Burget, professor of physiology at the University of Oregon Medical School, Portland, has received a grant to aid in studies on the physiology of the esophagus and cardia, and Dr. Dean A. Collins, instructor in physiology at the University of Minnesota, a grant for the purpose of aiding in some work on hypertension following partial ligation of the renal arteries.

DR. HANS ZINSSER, exchange professor from Harvard University to the University of Paris, is continuing his studies on typhus at the Pasteur Institute. He is working in a laboratory placed at his disposal by Professor Nicolle and is also giving lectures on bacteriology in the medical school.

DR. KARL T. COMPTON, president of the Massachusetts Institute of Technology and president of the American Association for the Advancement of Science, gave on May 10 a popular lecture on "Some New Developments and Applications of High Voltage Electricity" before the Lancaster Branch of the association.

DR. ROBERT CUSHMAN MURPHY, curator of oceanic birds at the American Museum of Natural History, lectured on "The Behavior of Penguins" at the annual initiation dinner of the Columbia Chapter of Sigma Xi on May 6.

DR. WALTER L. BIERRING, president of the American Medical Association, spoke on "The Historical Sequence of Medical Events" on May 10, before the Marquette University School of Medicine. After the lecture, Dr. Bierring was the honor guest at a dinner given by the advisory faculty, consisting of the heads of departments and divisions.

AT the twelfth annual meeting of the West Virginia Academy of Science held at Davis and Elkins College, on May 3 and 4, Dr. W. W. Cort, of the School of Hygiene and Public Health of the Johns Hopkins University, was the principal speaker.

AT the meeting of the British Institution of Electrical Engineers, on May 2, at which the presentation was made to Dr. F. B. Jewett of the Faraday Medal, Sir William Bragg delivered the twenty-sixth Kelvin lecture. His subject was "The Molecular Structure of Metals."

THE third prize contest for research on the genetics of mental disorders has been instituted by the Eugenics Research Association. The sum of $5,000 is available, budgeted as follows: First prize $3,000, second prize $1,000 and $1,000 for publication of the winning essays as monographs of the association, for small honoraria for the judges and for other expenses connected with the contest.

THE department of geology of Northwestern University is in receipt of a gift of $1,000 from the Penrose fund of the Geological Society of America for the purpose of completing a research project to determine the origin of South Park. The study was started two years ago by Drs. J. T. Stark, C. H. Behre, Jr., W. E. Powers and A. L. Howland in conjunction with Dr. J. Harlan Johnson, of the Colorado School of Mines, and Dr. Donald B. Gould, of Cornell College, Mt. Vernon, Iowa. The work hitherto has been financed in part by research grants given by Northwestern University. The expedition will leave on June 15 for Colorado, where two months will be spent in the field gathering additional data.

ACCORDING to *The Museum News,* a new 30-acre botanic garden has been opened recently in Trinity Park, Fort Worth, Texas. The garden was built by relief labor and largely financed through the CWA, the park department of the city contributing $7,000 for purchase of materials. The design, which combines formal and informal elements, is by S. Herbert Hare, of Kansas City. Fort Worth Botanic Garden is under control of the Board of Park Commissioners of the city. R. C. Morrison, city forester, had charge of the development of the garden and is supervising its maintenance. The park department has allotted $9,000 this year for maintenance of the garden.

IT is reported by special cable to *The New York Times* from Antofagasta that members of the British scientific expedition have arrived there and will establish a base 14,000 feet above sea-level on Mount Aconquilcha in the Chilean Andes in order to study the effects of the altitude. Complete equipment has been brought by the expedition, which includes Dr. Forbes Heys, of Harvard University, and Dr. Bryan Mathews, of the University of Cambridge. The constant failures to climb Mount Everest and other peaks have decided the members of the expedition to make a complete study of conditions of life at high altitudes.

A 50,000-ACRE tract in Hyde County, N. C., that is being restored to the swans, geese and ducks as part of the waterfowl restoration of the Bureau of Biological Survey, has been reserved and set apart by

executive order as the Lake Mattamuskeet Wildlife Refuge. Lake Mattamuskeet originally was a body of shallow water about 12 miles long and 7 miles wide. Several years ago an attempt was made to drain it, but the plan proved impractical. The drainage operations deprived waterfowl of one of the best resting and feeding areas on the Atlantic Coast. Now, with funds from the Federal Emergency Relief Administration for the retirement of submarginal lands, the government is purchasing the lake bed and permitting the lake to restore itself naturally. Swans, geese and many species of ducks—principally pintails, widgeons, mallards and black ducks—are found in numbers on the water areas available. Even the drainage of the lake bed did not deter some birds from returning season after season to rest on the surface of the canals and low places, and it is expected that the restored lake will again attract large concentrations of swans and other waterfowl.

PRESIDENT ROOSEVELT has requested the State Department to approach the Canadian government on joint action to preserve Niagara Falls in its present beauty. His move was occasioned by three landslides at the falls which tore down tons of rock and made indentations in the semicircle of cascading water. The last slide was in December. The President has asked the State Department to propose international construction or remedial works to preserve the falls through the special International Niagara Board. He appended the proviso that nothing in any such agreement should affect the permanent allocation of water rights or further divert Niagara water to the use of private power companies. In 1929 a treaty looking to protection of the falls was passed by the Canadian Legislature, but was held up in the U. S. Senate when a private power development clause was criticized.

DUKE UNIVERSITY announces the establishment of graduate scholarships and fellowships in forestry, carrying stipends which range from $250 to $650. Preference will be given to men who have studied French and German and who have already obtained technical or professional training as represented by a degree from a school of forestry of good standing. Major work, which may be used toward an advanced degree, should be in one of the following fields of concentration: forest-tree physiology, silvics, forest soils, silviculture or forest management. The work will be closely coordinated with research being conducted in the Duke Forest and in the university laboratories and greenhouses by the forestry, botany and zoology staffs. Full information may be obtained from the Director, Duke Forest, Duke Station, Durham, N. C.

A CORRESPONDENT of the London *Times* writes as follows: "For years there has been a division of opinion between the British Empire, the United States, Scandinavia and Holland on the one side, and most of the Latin nations on the other, as to the functions of the International Institute of Agriculture in the field of agricultural science. Countries such as the United States or those of the British Empire possess national or imperial means for the dissemination of scientific information, and spend for this purpose more than the International Institute in Rome can afford. At a meeting of the permanent committee of the institute on March 22 in Rome it was decided, on the advice of a panel of scientists, presided over by Sir John Russell, director of the Rothamsted Experimental Station, that the institute shall in future retire from the more purely scientific side of the information service and concentrate upon the practical and international aspects of such work."

WE learn from the London *Times* that the governor of Bengal has inaugurated a National Institute of the Sciences of India, of which the object is to promote scientific knowledge in India. The institute will act through national committees, and will serve as a national research council for the undertaking of work of national and international importance required by the public and the government. It will be a coordination body, not competing with existing academies, but bringing them into cooperation. The headquarters will be in Calcutta, and the membership will be 125 foundation fellows, with the addition of 10 elected annually. Dr. L. L. Fermor, director of the Geological Survey of India, is the first president.

DISCUSSION

FOREIGN GEOGRAPHIC NAMES

POST-WAR changes in foreign geographic names are disconcerting to teachers of geography, to students and to the general public. American publications, whether written by geographers or others, show no consistency in the adoption of "new" names. The accuracy of publications using foreign geographic names is challenged because of their failure to adopt new forms or because new forms are used in some instances and not in others. On occasion such changes may be cited to discount a writer unfairly—the situation is becoming increasingly critical and therefore, it seems, deserves aggressive action by authoritative bodies.

Students are confronted to-day with a variety of

text-books, so-called work-books, exercise sheets of different sorts, and political, economic and other kinds of atlases, among which there is no accord with respect to the form of foreign geographic names. One large commercial atlas shows no old names. Naturally students are bewildered and ask which one of these is correct. They may sit in courses offered by several different instructors, among whom there is no agreement as to the proper form, thus giving rise to further confusion.

The public press has shown an inclination to adopt some of the new names even without mention of the old. Peiping, Manchukuo, Oslo, Istanbul, Marseille and a few others are already in common use, but the same editors seem reluctant to use Firenze, Venezia, Praha, Warszava, S'Gravenhage or Manaus. Historians, too, hesitate to adopt the "new" names. Like others, they fear their readers may not recognize these names and hence may lose the purport of their reference, and they do not wish to clutter up the page with dual names, one within a parenthesis and one outside.

We enclose the word *new* in quotation marks because these names are new only to the uninitiated. Rather are they mostly old names resurrected in consequence of the stimulated post-war nationalism or names which have always been in use by the natives of the respective countries who now wish to have those names used internationally in the place of translations or even transliterations heretofore given the preference. Exceptions to this statement include names in the U. S. S. R. which are new not only to the outside world but to the nationals themselves.

To make matters even more perplexing, we are confronted with differences in usage of geographic names within some of the foreign countries where minorities wield considerable influence. In Finland a commission was set up to decide upon the official forms. Although both the Swedish and Finnish languages have official recognition in the courts and although in a number of centers where the Swedish-speaking people are in the majority the Swedish name is cited as official, most of the official geographic names applied to natural features, as well as political units, have been designated by Finnish forms. Nevertheless, the Swedish Finns are reluctant to adopt these latter forms and persist in the use of the names in vogue when Finland was under Swedish rule.

A somewhat similar bi-lingual struggle has manifested itself in Czechoslovakia, although much less emphatically than in Finland, owing to the fact that German is not an *official* alternative language. The German element in the population gives its preference to German geographic forms which many countries, including our own, have used for years and which are still widely used in the face of Czech desires that they be abandoned.

No doubt one of the first reactions of the reader to the comments thus far offered brings the suggestion that we are already provided with boards who have passed upon proper forms. The work of the U. S. Geographic Board and of the Permanent Committee on Geographical Names for British Official Use has unquestionably been well done, but their deeds are relatively little known among the mass of people, including great numbers of teachers. It is one thing to make these decisions, but quite another to disseminate them.

The Committee on Geographic Names, recently organized within the U. S. Department of the Interior, might well join hands with the British Committee for the purpose of securing repeated publicity of their conclusions through the public press. They might also enlist the assistance of all map publishers. This effort, combined with an educational campaign, would establish common usage of a single form for each political or natural geographic phenomenon of the earth.

By adopting a standardized method for showing both old and new names until such time as the old names may be dropped, if that seems desirable, all persons would eventually use the same names. The new name might be followed by the old name in parenthesis. That this method contains at least the essence of possible success may be indicated by the experience of the city of Chicago when its local government decided to change the house-numbering system. It was proposed that for a time the old number be carried along with the new number. There was the customary opposition by the conservatives, owing to the fear that two numbers would be confusing, but the objections were swept aside and the double system came into being. In the course of two or three years the old numbers vanished; the new numbers rendered effective service and the change was completed without hardship or serious heartaches. Had this situation been left to its own devices and undirected, the switch-over would hardly have been successfully accomplished.

If we were concerned with one or two occasional changes in geographic names the matter of universal adoption would not assume serious proportions. But when changes occur upon a wholesale scale resulting in confusion, the public looks to the profession within whose realm such matters lie to help them out of their dilemma. If the ultimate adoption of all these new forms must await the trials of "common usage," the period of uncertainty may be prolonged unduly. On the other hand, if geographers can reach an accord a real service will be rendered.

EUGENE VAN CLEEF

OHIO STATE UNIVERSITY

FURTHER ATTEMPTS TO GROW CHILOMONAS PARAMECIUM IN INORGANIC MEDIA

Chilomonas paramecium, although one of the cryptomonad flagellates, has generally been considered saprozoic in nutrition, and thus dependent upon organic sources of nitrogen. This belief has been supported by the investigations of Pringsheim[1] and Loefer.[2] Mast and Pace,[3] however, have stated that this flagellate is able to synthesize protoplasm from inorganic substances alone. In view of this apparent contradiction, the earlier experiments of Loefer have been repeated, using some of the media of Mast and Pace and following their technique as well as that previously developed in our own laboratory. The strain of *Chilomonas paramecium,* the one used previously by Loefer, was isolated at Woods Hole in 1932 and has since been maintained in bacteria-free cultures.

"Solution D" of Mast and Pace and a similar solution, with NH_4NO_3 substituted for NH_4Cl, were used as inorganic media in the depression-slide technique of Mast and Pace and the culture-tube technique of Loefer. Growth was always obtained in the first transfer from a peptone stock culture, and sometimes in the succeeding second and third transfers. In further transfers, however, our strain of *C. paramecium* failed to grow in the inorganic media. Even the addition of glycocoll, as used by Mast and Pace ("Solution B"), sometimes failed to prolong growth of the flagellates beyond the fourth transfer. It would seem, therefore, that our strain of *Chilomonas paramecium* is unable to synthesize protoplasm from ammonium compounds and other inorganic salts, and is thus quite different in this respect from the strain used by Mast and Pace.

J. B. LOEFER
R. P. HALL

NEW YORK UNIVERSITY

SHALL SMOKY CITIES GO TREELESS?

THE severe limitations imposed by city air pollution on decorative and ornamental vegetation has been brought to our attention by Mr. Kenneth Soergel, landscape gardener, State Capitol Park, Harrisburg, Pa. The base plantings at the Capitol building are described by him as being largely evergreens, consisting of Taxus, Juniper, Cryptomeria, Pine, Spruce and Rhododendron. Only the Taxus is said to be doing well; all others are "low in vitality, with many dying or beyond recovery." It is added that uncontrolled railroad smoke and the city heating plant are three blocks east of the Capitol and that large hotels facing the park also have heating plants. The result stated is "excess of smoke."

As a result of our own experiments in helping to protect some evergreens against damage by air pollution, we have recommended to the state gardener a process of mechanical spraying, employing soap, water and a chemically neutral detergent. Cohen and Ruston, in "Smoke, a Study in Town Air," report on tests of the efficacy of actual solid deposits to lower the rate of assimilation of CO_2 by plants. They found that cleaning of the leaves raised plant efficiency by about 65 per cent., but still left the plant far short of the rate of assimilation it would have had in rural air.

Posed, therefore, is the question: If smoke remains unabated and the most widely used evergreens can not live in polluted air, can substitutes be found, and if not, are we not faced with a problem for scientists generally, a problem that goes beyond the bounds of botany?

H. B. MELLER
L. B. SISSON

MELLON INSTITUTE

THE WILLIAM HERBERT CENTENNIAL

IN recognition of the lasting influence of William Herbert's "Amaryllidaceae,"[1] which appeared in 1837, the American Amaryllis Society has voted to observe the William Herbert Centennial in 1937. The society will dedicate its Year Book in that year to Herbert and his work. A comprehensive biography of the divine, scholar and scientist will be published together with a reprint of his stimulating essay, "On Crosses and Hybrid Intermixtures in Vegetables," which apparently has been obscured because it is appended to the "Amaryllidaceae."[1] This essay is a most remarkable one, considering the date when it appeared. Reference is made to only one passage to serve as an illustration.

Herbert crossed each of two turnip varieties with hairy leaves and straw-colored flowers on the Swede or ruta-baga with smooth leaves and bright yellow flowers. The first generation plants had leaves like the male parent. He does not indicate the color of the flowers. The greater part of the second generation individuals secured by selfing the first generation hybrids had bright yellow and a smaller part had straw-colored flowers. He observes that these colors were not blended nor did they modify each other. He does not give information about the leaf characters in the second generation. Herbert's own words as they appear on page 370 are as follows:

> I impregnated in 1834 with great care the Swedish turnip (ruta-baga) with pollen of the white, and another branch thereof with that of the red rooted turnip. . . . The seed was sown immediately, and the plants of both

[1] E. G. Pringsheim, *Beitr. allg. Bot.,* 2: 88–137, 1921.
[2] J. B. Loefer, *Biol. Bull.,* 66: 1–6, 1934.
[3] S. O. Mast and D. M. Pace, *Protoplasma,* 20: 326–358, 1933.

[1] "Amaryllidaceae; preceded by an attempt to arrange the Monocotyledonous Orders, and followed by a Treatise on Cross-bred Vegetables and a Supplement." London: James Ridgeway and Sons. 1837.

crosses though late, formed pretty roots. The leaves differed in appearance from those of Swedes, and did not, like them, retain the rain water on their surface. In the following spring they were set for seed in two different situations where no extraneous pollen might have access. The flowers of the greater part were of the bright yellow of the two male parents; a smaller portion of each lot produced a straw-color blossom, like that of the Swede; but not one shewed the least disposition to an intermediate tint; and it seemed as if those two colours were incapable of blending, or modifying each other.

William Herbert, a brilliant divine and scholar, carried on his plant researches as a hobby. His monograph on the "Amaryllidaceae" is a landmark on the phylogeny of this group, and his extensive work in plant breeding, mostly with *Amaryllidaceae,* and other ornamentals, has placed him in the same rank as Thomas Andrew Knight, a pioneer plant breeder.

HAMILTON P. TRAUB
"MIRA FLORES"
ORLANDO, FLORIDA

THE GANESH PRASAD PRIZE

THE great interest shown by Hindu scholars during the last few years in the history of mathematics in India is well known. During nearly a century the subject had been so neglected as to give the impression that such early English writers as Colebrooke and Taylor had exhausted the subject. Among the later Hindu translators of the early works the first of the outstanding Hindu scholars was Rangacarya, whose edition of Mahavir is well known. There have also been a number of later scholars who have published certain expository articles upon the history of the subject and have thus awakened a new interest in various semi-forgotten works of merit. Several of their contributions have appeared in such publications as the *American Mathematical Monthly* and the *Scripta Mathematica,* and others are promised for the new series about to appear under the name of *Osiris,* sponsored by the History of Science Society.

In view of the present activities shown by Hindu scholars it is interesting to know that the Calcutta Mathematical Society has recently announced for the subject of the competition for the "Krishna Kumari-Ganesh Prasad Prize and Medal" the following: "Lives and works of the ten Famous Hindu Mathematicians: Aryabhatta, Varamihir, Bhaskara I, Lalla, Bramhagupta, Sridhar, Mahavir, Sripati, Bhaskara II, Naryana." (Spellings of proper names as in the announcement.)

In view of the excellence of various recent articles by Hindu scholars, it may be expected that the winner in the contest will offer to the English-speaking world a work of outstanding importance.

DAVID EUGENE SMITH

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

MINUTES OF THE EXECUTIVE COMMITTEE MEETING

THE regular spring meeting of the executive committee was held in New York City on April 14, 1935, in the office of The Science Press, Grand Central Terminal, with the following members present: Dr. Cattell, *chairman,* Drs. Caldwell, Compton, Conklin, Curtiss, Livingston, McKinley, Ward, Wilson and Woods. Dr. Hildebrand was excused for absence.

It was reported for record that minutes of the last meeting held in Pittsburgh in December were approved by mail.

The following resolutions, drawn up by the treasurer, laid before the executive committee in December and held over for further study, were brought up for final action and after amendment adopted in the following form as representing the general policy of the council:

No expenditure shall be authorized or made from the permanent funds of the association in the keeping of the treasurer except in pursuance of a previous action by the council or by the executive committee under Article IV, Section 1, of the by-laws.

The council at the annual meeting in each year shall make general appropriations for the current fiscal year; but nothing contained herein shall prevent the council making special appropriations at any meeting.

It shall be the duty of the finance committee to provide for the safe custody of all financial resources of the association and to determine all matters relating to purchase and sale of its securities. It shall consider and recommend to the council from time to time such measures as in its opinion will promote the financial interests of the association.

The need of a change in the present financial arrangement in payment of subsidies to affiliated academies, as previously announced at Atlantic City and Pittsburgh, was studied, and after considerable discussion it was voted that in lieu of allowances sums should be paid to affiliated academies in the form of grants for research. Dr. Livingston, the general secretary and the permanent secretary were appointed a committee to perfect the plan.

The general secretary, Dr. Caldwell, presented a report on the work thus far done in establishing local

branches and on other matters pertaining to his office. On his recommendation it was voted to authorize the acceptance of the following organizations as local branches: Westchester (N. Y.) Institute of Sciences; Phoenix (Arizona) Local Branch; Southern Florida Science Association at Miami; Southern Rhode Island Local Branch at Kingston.

The executive committee looked with favor on the establishment of a branch at Mobile, Ala., subject to approval of the state academy.

The executive committee voted to appropriate $750, or as much of that amount as may be needed, for clerical and traveling expenses of the general secretary's office until September 30, 1935.

The executive committee approved the following outline, presented by Dr. Compton, as representing general policy of the association.

Exhibits sponsored by the American Association for the Advancement of Science should be limited strictly to the following categories:

(1) Exhibits which illustrate scientific studies, phenomena or progress.

(2) Exhibits of apparatus, methods or materials which are useful in scientific instruction or research.

(3) Exhibits of publications which are of value in the dissemination or advancement of knowledge in science.

(4) Exhibits of such other types as may be clearly defended for their value as aids in education or research in science.

It shall be the duty of the Director of the Exhibition to see that exhibits are limited to those falling within the above classifications.

The executive committee accepted the resignation of Dr. E. B. McKinley as secretary of the section on medical sciences. On recommendation of the section committee, Dr. Vincent du Vigneaud was elected secretary of the section to succeed Dr. McKinley, his term of office to continue until December, 1936.

Dr. Moses Gomberg was elected a member of the committee on grants to represent chemistry, succeeding Dr. Roger Adams, resigned, his term of office to continue until December, 1938.

Dr. Herbert Osborn was appointed the association's representative on the board of trustees of *Biological Abstracts,* his term of office to continue until April, 1939.

Extended statistical reports on association finances, membership, circularizations inviting new members and special publications, were discussed and approved.

Dr. Compton was authorized to sign the indemnity-bond renewal covering the permanent secretary and the executive assistant.

On recommendation of the special committee on types of membership (Drs. F. V. Coville and A. F. Woods and the permanent secretary) the following by-law was adopted: Members who have paid annual dues for 50 years may be excused from further payments and still retain all the privileges of active membership.

The permanent secretary presented an outline showing for the endowment funds of the association the exact conditions under which they were received.

The general secretary, Dr. Caldwell, was added to the membership of the committee on adult education.

It was voted to adopt a resolution subsequently worded as follows:

The Executive Committee of the Council of the American Association for the Advancement of Science urges all members of the Association to give careful study and consideration to the report of the Commission of Inquiry on Public Service Personnel. (Now available in book form published in full by Whittlesey House.) A non-politically administered Civil Service designed to secure for government work the best qualified workers is essential if government is to function efficiently. The organization at least of the professional and scientific services on a career basis is essential to secure and hold young men and women of capacity and character. They must have opportunity for advancement through service and growth to posts of distinction and honor. There must, of course, be adequate provision for the elimination of the unfit. We recognize that in many branches of the professional and scientific service in the Government and in several of the States great progress has been made along the lines recommended by the commission. In these services the quality of personnel secured and maintained is fully equal to comparable positions outside the Government service, though salaries, especially in the upper brackets, are frequently much lower. The A. A. A. S. will support all sound proposals for the improvement of public scientific and professional service.

Dr. J. B. Macelwane was elected a member of the committee on grants, succeeding Dr. E. W. Berry, resigned. Dr. Macelwane is to represent geology and his term is to continue until December, 1936.

The permanent secretary announced that Professor F. J. E. Woodbridge, of Columbia University, would deliver the Phi Beta Kappa address at the St. Louis meeting.

Dr. Carl Snyder was elected a fellow of the association.

The permanent secretary announced that the Section on Social and Economic Sciences elected Carl Snyder as a member of the section committee, his term of office to continue until December, 1938.

The Society for Research in Child Development, subject to receipt of the formal application, was accepted as an affiliated society with one representative in the council.

The American Association of Colleges of Pharmacy was accepted as an associated society.

The Missouri Academy of Science was accepted as an affiliated academy with one representative in the council without any financial arrangement, in accordance with action taken in the recent affiliations of other academies.

The Institute of Aeronautical Science was accepted as an affiliated society with one representative in the council.

The Society for Research on Meteorites was accepted as an associated society.

The American Division of the International Association for Dental Research was accepted as an affiliated society with one representative in the council.

The chairman announced that on request of the special committee on research fellows the report of that committee now pending before the council had been withdrawn.

The permanent secretary announced the appointment by the president of Professor A. P. Wills as the representative of the association on the Sectional Committee on Electric and Magnetic Magnitudes and Units of the American Standards Association.

The permanent secretary presented a printed copy of the address by Dr. Mark H. Liddell on "A New Theory of Sound," read at the Pittsburgh meeting. This is the final report of a research made possible by a grant from the association several years ago.

The permanent secretary announced that railroad rates for the Minneapolis meeting have been limited by the traffic association to bona-fide members (and their families) of the association and its associated societies.

The committee adjourned, to meet in Minneapolis on Monday, June 24, at 9:00 A. M.

HENRY B. WARD,
Permanent Secretary

STATE ACADEMIES

THE PENNSYLVANIA ACADEMY OF SCIENCE

THE eleventh annual meeting of the Pennsylvania Academy of Science was held on April 19 and 20. The academy was the guest of Dickinson College, Carlisle, Pennsylvania. Titles of 59 papers and demonstrations were included on the program and, except for the brief business meeting, these filled the session. The annual dinner on Friday evening was followed by the presidential address, "The First Decade of the Pennsylvania Academy of Science," by Professor S. H. Derickson. Dr. William W. Cort, of the Johns Hopkins University, guest speaker of the evening, addressed the society on "Biological Studies on Human Parasites." A total attendance of 103 members and guests registered, besides 41 members of the Junior Academy. A representation of 35 physicists from the state met simultaneously, partly as a sectional group and partly in joint conference with the main body of the academy. The following officers were elected for 1935–1936:

President: Professor Edgar T. Wherry (botany), University of Pennsylvania.

Vice-President: Dr. T. D. Cope (physics), University of Pennsylvania.

Secretary: Dr. T. L. Guyton (entomology), Pennsylvania Department of Agriculture.

Assistant Secretary: Dr. V. Earl Light (biology), Lebanon Valley College.

Treasurer: Professor H. W. Thurston, Jr. (botany), Pennsylvania State College.

Editor: R. W. Stone (geology), Pennsylvania Topographic and Geologic Survey.

Press Editor: Dr. Bradford Willard (geology), Pennsylvania Topographic and Geologic Survey.

The 1935 summer meeting and field trip is to be held in the Poconos in August. The time and place of the 1936 annual meeting are to be announced subsequently.

BRADFORD WILLARD,
Press Secretary

THE ALABAMA ACADEMY OF SCIENCE

THE twelfth annual meeting of the Alabama Academy of Science was held at State Teachers College, Florence, Alabama, on Friday and Saturday, April 12 and 13, 1935.

There were ninety-nine members and guests registered, fifty-two papers presented in four sections and three demonstrations given. At the banquet on Friday evening Dr. Russell S. Poor, Birmingham-Southern College, gave the presidential address on "The South's Position in the Mineral Industry." Dr. George M. Hall, president of the Tennessee Academy of Science, was an honored guest.

Following the banquet there was a reception during which a demonstration with ultra-violet light of fluorescent minerals of Alabama was given by Dr. David L. De Jarnette, curator of the Alabama Museum of Natural History, and his assistant, James T. De Jarnette.

On Saturday morning Dr. Walter B. Jones, state geologist, conducted a geological field trip through the Muscle Shoals district. At noon an old-time Southern barbecue was given on the campus of State Teachers College by President H. J. Willingham of the college. In the afternoon an industrial trip under the direction

of Professor Floyd F. Cunningham, of State Teachers College, was taken to the T. V. A. developments. Among the places of interest visited were Nitrate Plant No. 2, which T. V. A. officials very kindly explained, the finished Wilson Dam and the new Wheeler Dam now under construction.

On Saturday morning the Alabama Junior Academy of Science held its third annual meeting at the same place. Twelve high schools from all parts of the state were represented.

The following officers were elected for the year 1935–36:

President, A. G. Overton, Alabama By-Products Corporation, Tarrant; *President-elect,* Walter B. Jones, state geologist, University; *Vice-president* (Biology and Medical Science), C. M. Farmer, State Teachers College, Troy; *Vice-president* (Chemistry, Physics and Mathematics), B. F. Clark, Birmingham-Southern College, Birmingham; *Vice-president* (Geology, Anthropology and Archeology), T. G. Andrews, University of Alabama; *Vice-president* (Industry and Economics), W. M. Mobley, Alabama By-Products Corporation, Tarrant; *Editor of the Journal,* E. V. Jones, Birmingham-Southern College, Birmingham; *Secretary,* Septima Smith, University of Alabama; *Treasurer,* B. F. Clark, Birmingham-Southern College, Birmingham; *Councillor to the A. A. A. S.,* P. H. Yancey, Spring Hill College, Mobile.

The next meeting will be held at the Alabama Polytechnic Institute, Auburn, Alabama, some time in March, 1936.

P. H. YANCEY

THE TENNESSEE ACADEMY OF SCIENCE

THE spring meeting of the Tennessee Academy of Science for the year 1935 was held on April 26 and 27 at the Reelfoot Lake Biological Station. There were three sessions on Friday and two on Saturday in the laboratory building. Headquarters were at the Walnut Log Lodge, four hundred yards away. Excursions were taken on Saturday afternoon on and around the lake.

At the meeting on Saturday evening, Dr. George M. Hall, president, presiding, Dr. A. R. Middleton, professor of biology, University of Louisville, secretary of the Kentucky Academy of Science, gave an address on "A Summer in Honduras."

Sixteen of the twenty-four papers were by members of faculties of schools. Two were by members of the academy residing outside of Tennessee—Dr. Mary Minerva Steagall, head of the department of zoology, Southern Illinois State Normal University, Carbondale, Illinois, and Dr. Emily Barry Walker, head of the science department, East Texas State Teachers College, Commerce. Schools in Tennessee represented were: in East Tennessee, the University of Tennessee, Knoxville, and the State Teachers College, Johnson City; in Middle Tennessee, Vanderbilt University and George Peabody College, Nashville; in West Tennessee, Southwestern and State Teachers College, Memphis, Lambeth College, Jackson, Freed-Hardeman College, Henderson. Departments of science leading in the number of papers were: biology 5, geology 4, public health 3.

The academy holds two meetings each year—one at Nashville in the fall and one either in East or West Tennessee in the spring. Reelfoot Lake is in the northwest corner of the state. The attendance of between forty and fifty members at the meeting was consequently fully as many as expected. This far-away place was chosen for the meeting on account of the location there of the Biological Station, which is under the control and management of the Tennessee Academy of Science. Dr. Middleton, who delivered the address on Saturday evening, is a member of the council of the American Association for the Advancement of Science.

The general appropriation bill passed by the House at the recent session of the Legislature carried an appropriation of $2,500 to the academy to be expended during the biennium 1935–1937 for the benefit of the station, but the Senate postponed consideration of the bill to an extra session of the Legislature in May or June, thus embarrassing the academy in arranging for work at the station this summer.

J. T. MCGILL,
Secretary-Treasurer

THE MINNESOTA ACADEMY OF SCIENCE

WITH an attendance of three hundred the Minnesota Academy of Science held its third annual meeting at the University of Minnesota on Saturday, April 13. The program contained 8 papers, as follows: "Fifty Years' Experience in the Weather Bureau," Mr. U. G. Purssell, formerly head of Minneapolis Weather Bureau; "Scientific Concentrates," Dr. W. C. Croxton, State Teachers College, St. Cloud; "The Rhythm of Blossoming in Flowering Plants with Special Reference to Hay Fever," Dr. C. O. Rosendahl and A. O. Dahl, University of Minnesota; "Soil Erosion Demonstration Areas in Southeastern Minnesota," R. H. Davis, Soil Erosion Service, U. S. Department of the Interior; "Shelterbelts—Futile Dream or Attainable Benefit," Dr. J. E. Aikman, senior botanist, Lake States Forest Experiment Station; "A Configurational Approach to the Study of Sound," Dr. A. R. Root, Hamline University; "Utilization of Some Farm Wastes," Dr. C. A. Mann, University of Minnesota; "Milking the Rubber Tree," Dr. E. C. Stakman, University of Minnesota.

The academy voted to cooperate with the American

Association for the Advancement of Science at the time of its meeting in Minneapolis.

The following officers were elected:

President, Dean Edward M. Freeman, University of Minnesota.

Vice-president, Dr. L. M. Gould, Carleton College.

Secretary-treasurer, H. K. Wilson, University of Minnesota.

Councilor, Dr. L. H. Powell, Director of the St. Paul Institute of General and Applied Science.

The next annual meeting will be held in Northfield, Minnesota, with Carleton and St. Olaf Colleges as hosts.

H. K. WILSON,
Secretary

SCIENTIFIC APPARATUS AND LABORATORY METHODS

ON AN ARRANGEMENT FOR STUDYING THE CONDITIONS WITHIN DIFFUSION LAYERS

VERY few experimental studies are concerned with the manner in which the concentrations and electrical potential are built up in the boundary between two different solutions, across which boundary diffusion takes place. From the theoretical side the main interest has so far been the diffusion or liquid junction potential. In order to calculate this potential Planck[1] and Henderson[2] have developed theories which differ in assumptions regarding the ionic composition in the diffusion layer (boundary); Planck's theory, derived from Nernst's[3] treatment of electrolyte diffusion, claims that individual ions may under certain circumstances become accumulated in the diffusion layer in higher concentrations than are present in the two surrounding solutions (*cf.* Plettig,[4] Planck[5]). Henderson, on the other hand, assumes that all ionic concentrations fall off linearly in the boundary. The experimental efforts to settle which theory is valid have, as far as the author has been able to find, used only measurements of the electrical potential (for literature *cf.* Plettig and Planck). The question is hardly settled as yet.

To judge from the theories, however, the evaluation of the ionic concentration distributions within the diffusion layer should offer more conclusive evidence than can be obtained from the potential measurements, which, as a rule, should theoretically not differ much.

Trying to measure the concentration distribution the author first used a diffusion boundary consisting of an agar plug in a glass tube. On the two sides of the plug large volumes of the stirred solution were placed. After a sufficiently long time the plug was sliced in parallel sections and analyses were performed. This method, employed to some extent by previous workers on the "Liesegang structures," however, did not prove to be convenient for observing the development of the final steady state, nor was it good for following the behavior of the potential within the layer.

In order to obviate these disadvantages the following arrangement was adopted: A number of Cellophane or collodion sheets (5 to 9) were clamped between suitable washers in such a manner that about 10 cc of solution could be placed in each of the "chambers" so obtained. The two outside "chambers" were fed continuously with the solutions under investigation by means of a special air-lift suction pump. The content of each "chamber" was stirred. With microanalyses on samples from the "chambers" (apparently corresponding to different surface elements in the diffusion layer) the building up of the concentrations and potential could be conveniently followed. (It should be emphasized that this multimembrane arrangement is not equivalent to one homogeneous diffusion layer from a kinetic point of view. But when the time factor disappears, *i.e.*, in a stationary state, the conditions in the "chambers" correspond to those in the interfaces of a "sliced" homogeneous diffusion layer.) When a 'steady state' was attained (generally within 24 hours) the results of the experiments showed conclusively in all hitherto investigated cases that the behavior of the ionic concentrations, at least qualitatively, was in accord with the Planck-Plettig predictions.

This "multimembrane" method has also been useful in investigations of cases of diffusion where chemical reactions take place.

The details of the results here referred to and some attempts to discuss the biological importance of these rather peculiar conditions in a "membrane" will be published elsewhere.

TORSTEN TEORELL

THE LABORATORIES OF
THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH
NEW YORK CITY

[1] M. Planck, *Wied. Ann.*, 40: 561, 1890.
[2] P. Henderson, *Z. physik. Chem.*, 59: 118, 1907.
[3] W. Nernst, *Z. physik. Chem.*, 2: 617, 1888; 4: 154, 1889.
[4] V. Plettig, *Ann. Physik.*, 5: 735, 1930.
[5] M. Planck, *Sitzb. preuss. Akad. Wiss.; Physik.-math. Klasse*, 1930, 367; 1931, 113.

A SIMPLE RELIABLE TIME CLOCK

IT is not infrequent that workers in physiological laboratories supplied with direct current, where syn-

chronous motors can not be used, feel a very acute need for an inexpensive, transportable time clock to activate more than one time signal. A device fulfilling these specifications has been in use in this laboratory for the past year and has been found reliable and accurate. The apparatus has a further advantage in that it is inexpensive, costing, exclusive of the mechanic's time, less than $15.00.

It is essentially a rotating switch driven by means of a direct current electric phonograph motor. These direct current motors may be obtained regulated by a governor to run at a normal speed of 78 revolutions per minute. This speed, however, may be increased or decreased by as much as twenty revolutions per minute in either direction. Hence it is possible to regulate the motor to obtain one revolution per second. For our ordinary laboratory work we use two models and find them adequate for most physiological class work. The first, so regulated as to produce one revolution per second, drives a rotating spring contact directly. The second has the shaft speed reduced by means of a worm and gear to one revolution per minute. In both cases the rotor makes a contact every 90°. Thus, in the direct drive, signals are given at 1, 0.5 and 0.25 second. The second model gives signals at one minute or 30 seconds or 15 seconds. It is used primarily for either slow muscular contractions, *i.e.*, uterine, or for respiratory or metabolic determinations. The details of the rotating switch and its electrical connections are given in Fig. 1.

The rotor is fastened directly to the shaft, which is also grounded to the battery. The circuit is closed when the rotor strikes one of the four induction switch

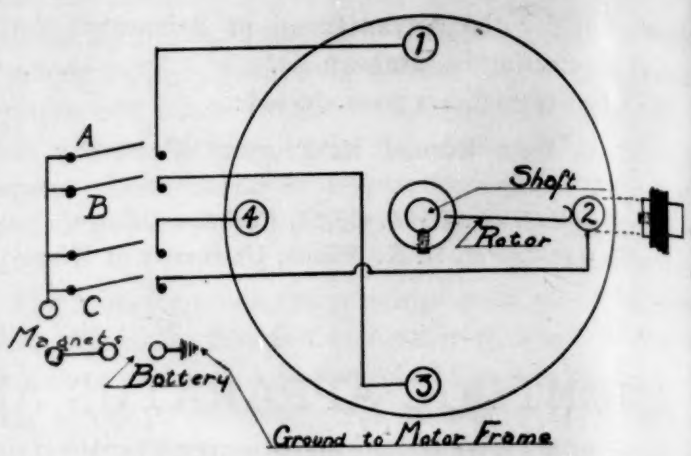

FIG. 1

points (1–2–3–4). These points are inserted 90° apart in a vulcanite disk.

Thus, closing switch A or B, one contact per revolution is made, closing the double pole switch (C) gives two equidistant contacts, closing all switches causes four contacts or a minimum time interval. It has been found advisable when a heavy electrical load is placed upon the contacts to use a two microfarad condenser in order to reduce the spark and so preserve the smoothness of the contacts. The entire unit is most compact. Even with the relatively large reducing gear it may be enclosed in a small box and easily transported from laboratory to laboratory. Since the motor is very quiet we have found it advisable to connect a small lamp in the motor circuit as an indicator to prevent battery wastage.

G. B. RAY
H. LEWINE

LONG ISLAND COLLEGE OF MEDICINE

SPECIAL ARTICLES

MUTATION RATE FROM OLD DATURA SEEDS

THE cytological aberrations in root-tips of *Crepis* plants from aged seeds, found by Navashin,[1] seemed to point to an influence on mutation rate by conditions that might be obtained in nature. Last year we reported high rates of pollen abortion mutations from seeds of *Datura stramonium* that were aged by storing up to ten years in the laboratory.[2] The same material has since shown that aging seeds induces also a high rate of visible recessive mutations.[3] Later, through the cooperation of H. B. Derr, county agent at Fairfax, Va., we obtained seeds that, apparently, had been buried for 22 years in the soil beneath a house.

These seeds, so far as we are aware, are the only material of the kind which has been subjected to genetic study. In view of the suggestions from earlier work that mutations induced by aging seeds may play a rôle in evolution in nature, it seems desirable to give the evidence upon which we base our belief that these seeds had remained undisturbed for at least 22 years. The house under which the seeds were found was built about 1909, and was bought by Mr. Derr in 1911. The kitchen was added in 1912. In 1924 a cellar was dug beneath part of the house in order to install a furnace. The excavated soil, piled outside, yielded a large crop of vigorous jimson weeds. Ten years later, in the spring of 1934, Mr. Derr took some soil from under the house and again obtained a number of jimson weeds. In June, 1934, one of us visited Mr. Derr's

[1] M. Navashin, *Nature*, 131: 436, 1933.

[2] J. L. Cartledge and A. F. Blakeslee, *Proc. Nat. Acad. Sci.*, 20: 103–110, 1934.

[3] A. F. Blakeslee and A. G. Avery, Abstract, *Amer. Nat.*, 68: 466, 1934.

house and with him dug out four bags of soil at a depth of about two to eight inches from unexcavated parts of the cellar. From these soil samples more than 500 Datura plants, together with 168 plants of other genera, chiefly *Acalypha* and *Chenopodium*, were grown at Cold Spring Harbor. There seems to have been no possibility of seeds being carried into this location after the building of the house and its kitchen. The foundation walls (brick for the house and concrete for the kitchen) extend below the ground surface and also about two feet above this level to the floor of the house. A small, externally shielded ventilator was well above the ground line; the outside cellar door was covered, and the closed windows were under the porch. The soil was a hard, dry clay.

Controls were grown from seed of wild plants on Mr. Derr's farm, harvested in 1933, and from the standard inbred Line 1 which furnished test and control seed for our aged seed experiments. Because of a change in the sampling method a higher proportion of the pollen abortion mutations that actually occurred may have been found in the 1934 experiments than was found in 1933. In 1934 a flower from each of the two main forks of each plant was examined, while in the 1933 season the two flowers were taken at random and were, no doubt, in many cases from the same main branch. Since most of the mutations involve sectors of half or less than half of a plant, more may be expected to be found by the method of sampling both main forks. The results from these 22-year-old seeds and their controls are shown in Table I.

TABLE I

POLLEN ABORTION MUTATIONS (TWO-FLOWER SAMPLES)

From seeds—	Plants	Mutations	Percentage
RECORDS OF 1934			
Buried 22 years	427	8	1.8
1-year-old, control	47	0	0.0
1-year-old, Line 1 control	261	3	1.1
RECORDS OF 1933			
Aged 5 to 10 years in lab. (Line 1)	405	32	7.9
1-year-old, Line 1 control	331	2	0.6

One of the eight mutations found seemed to involve the whole plant; the others occurred in sectors of the plants. Five had the appearance of chromosomal mutations and three of the gene mutation type.

Heat treatment of barley[4] and *Crepis*[5] seeds is reported to have given effects like those of aging seeds. Line 1 plants from seeds that were treated at the Boyce Thompson Institute, through the cooperation of Dr. Wm. Crocker and Miss L. V. Barton, are now being grown for mutation rate studies. Preliminary tests have shown that mutations may be induced in *Datura* seeds by heat treatment and that the moisture content of the seeds subjected to heat is of great importance in this connection.

Plants from the buried seeds under discussion are not strictly comparable with our standard Line 1 used as a control, although there is no evidence that the two races would be expected to differ in mutability. The rate of pollen abortion mutations found in the 22-year-old seed plants is scarcely higher than that in the controls, and is much lower than that found in 1933 for seeds aged five to ten years in the laboratory. Taken as they stand, these results indicate that seeds buried in the soil under these more or less natural conditions were unaffected by whatever influences there may be to induce mutations, and that age alone does not greatly, if at all, increase the mutation rate.

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[4] F. Peto, *Can. Jour. Res.*, 29: 349–362, 1933.
[5] M. Navashin and P. Shkvarnikov, *Nature*, 132: 482, 1933.

THE RELATION OF WATER AND ELECTROLYTES TO METABOLISM

A CONSIDERATION of the views held regarding the regulation of water by the living organism reveals an interesting fact. Most workers in this field have stressed the physico-chemical aspects of the problem and have adopted what is essentially a non-vitalistic concept of water balance. Thus Fischer[1] regarded acidosis as being the primary factor in water retention. Schade[2] has emphasized alkalosis. Gamble[3] and his co-workers considered that the total amount of water was determined by the total electrolytes present in the organisms. Starling[4] pointed out the importance of the colloid osmotic pressure of the blood. Davis and Dragstedt[5] have shown how acidosis diminished the ability of the body to retain water. All this evidence points to a mechanistic concept of water regulation. In order to examine further the truth of this purely physico-chemical explanation of

[6] Aided by a research grant from the Penrose Fund of the American Philosophical Society.
[1] N. H. Fischer, "Oedema," pp. 209, New York, 1910.
[2] H. Schade, *Ergebn. inn. Med.*, 32: 425, 1927.
[3] J. L. Gamble, N. C. Putnam and C. F. McKhann, *Am. Jour. Physiol.*, Vol. 88, p. 571.
[4] E. H. Starling, "Fluids of the Body," pp. 186, 1909.
[5] H. A. Davis and L. R. Dragstedt, *Am. Jour. Physiol.*, 109: 88, 1934.

water balance, this investigation was undertaken. The very essence of the non-vitalistic theories is exemplified by the fact that salt water is retained much better by the body than is salt-free water.

A preliminary series of over 25 dogs was used. Isotonic solutions of 0.9 per cent. NaCl solution and 5 per cent. glucose solutions were injected intravenously in amounts from 2,500 cc to 4,000 cc. The oxygen consumption of the animal was measured before, during and after the injection at standard intervals. In all the animals a considerable increase in the oxygen consumption occurred from 100 per cent. to 500 per cent. above the basal level. The increase in O_2 consumption produced by equal amounts of 5 per cent. glucose solution was greater than that produced by 0.9 per cent. sodium chloride solutions. The amount of water lost was proportional to the increase in the oxygen consumption and metabolic rate. In 3 animals in whom an increased oxygen consumption did not occur during the injection death occurred. Water given by the alimentary tract increased the consumption but slightly. This is interesting in view of the fact that fluid by mouth is retained for longer periods than is fluid given by vein. Conversely, it was found that repeated blood-letting lowered the metabolic rate. In such animals, isotonic solutions were retained for longer periods.

Moreover, the diuresis was quite limited. In the light of these findings, it might be suggested that one of the fundamental factors concerned in water regulation is the oxygen consumption rate of the body tissues. Further work is proceeding along these lines.

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CALCIFYING FACTORS IN THE DIET OF SALAMANDER LARVAE

THE degree of calcification in salamander larvae was controlled by different calcifying agents, by variations in the Ca : P ratio or level and by use of diets with unlike growth-promoting properties. The results, recorded by x-rays, showed that salamander larvae do not differ widely from higher animal forms in their responses to calcification factors in the diet.

Larvae of *Triturus viridescens* fed on a synthetic diet of powdered beef muscle with cod-liver oil but without mineral addition were almost devoid of skeletal ossification. In contrast, a good calcification of skull and vertebral column appeared in other larvae, of the same age and origin, growing at like rate on a diet of milk powder combined with crude casein and containing the above vitamin D supplement. A poorer bone deposit in the limbs suggested that the ratio of calcium to phosphorus or the level of these minerals in the diet was not optimum for the tained vitamin D. Analyses for the calcium in total ash of animals from the two diet series figures forming a ratio slightly less than that of calcium in their diets.

The availability of vitamin D from the three mon sources and the relative quantities needed calcification in salamanders were indicated in fee larvae of *Amblystoma tigrinum* on a synthetic diet. During a period of two weeks, a more exten calcification was produced by exposure to ultra-vi light (2 or more minutes on alternate days at 11? from a Burdick mercury vapor quartz lamp) or feeding viosterol (1 R.U. to 10 gm of ration) than cod-liver oil (3 Steenbock R.U. to 10 gm of ratio Use of the milk diet without vitamin D supplem was not followed by as complete a lack of bone m erals as resulted when other larvae from the same of *A. tigrinum* were fed on the low-calcium meat with the cod-liver oil. This may have been due the presence of some of the calcifying factor in concentrated powdered form of milk or to the f that the high degree of purification of the casein this milk diet caused a lower growth rate and con quently a smaller rachitic tendency.

Larvae of *A. tigrinum* fed on the beef muscle with cod-liver oil but without mineral addition de oped a bowing of the limbs typical of rickets, this disease was sometimes indicated also by weak at the limb attachment or by abnormal contour jaws or of spine. Yet, even on the extremely l calcium content of the muscle diet, when the vita D supply was raised by irradiation (seven minutes alternate days during two weeks), a fair bone depo was made. On the beef muscle diet with cod-liver the bone deposit increased as the calcium was rai until the phosphorus became the limiting factor, an indication was given that the range of the Ca ratio required for salamanders is very like that nee by mammals and by the chick.

The sensitivity of response to variations in calci ing factors shown by these small urodeles, as well the ease and practicability with which they serve x-ray studies, points to a convenient means for b logical assay of calcifying agents.

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BOOKS RECEIVED

LEYBURN, JAMES G. *Frontier Folkways.* Pp. x+2 Yale University Press. $3.00.

SCHRÖDINGER, ERWIN. *Science and the Human Temp ment.* Translated by James Murphy and W. H. Jo ton. Pp. xxiv + 192. Norton. $2.50.

Tôhoku Imperial University: Science Reports. XXIII, No. 5. First Series. (Mathematics, Phy Chemistry). Pp. 259 + 9. Maruzen. Sendai.